Dr. Jacob D. Paz
7700 Wolf Creek Road
Las Vegas, NV 89128-6842

EMF-RAPID Program September 22, 1998
LCBRA NIEHS
NIH
P.O. Box 12233, MD EC-16
Research Triangle Park, NC 27709

Dear Sir:

I am enclosing my comments regarding the recent NIEHS ELF Report. I shall divide these into two sections; the first will deal with occupational and recreational exposures to ELF, the second will summarize the effects of chemiluminescence and ELF:

I am enclosing three abstracts of papers, which were presented at various professional meetings, and locations where they were presented. ELF Spot measurement of occupational exposure is listed in (Exhibit 1.) specifically:

1. Electromagnetic Survey of employees exposed to non-destructive testing
2. Survey of electromagnetic radiation exposure to analytical instrumentation
3. Electromagnetic profile in commercial and corporate aircraft.

ELF levels tests of recessional entertainment equipment are listed in (Exhibit 2.) for example:

1. Electromagnetic Exposure Survey Casino Gambling Video Machines
2. Electromagnetic Survey of Children Video Arcades
3. Electromagnetic Exposure from High Definition TV ranges from 08 to 2.0 Gauss taken at the screen (unpublished data).

Very few studies about exposure to ELF have been replicated. However, a recent review of the professional literature indicates that employing chemiluminescence technique has been duplicated. All measurements indicated that ELF exposure of lymphocytes enhanced chemiluminescence response (see Exhibit 3.). I am also enclosing an abstract of a recent Russian publication.

In conclusion I'll to suggest that the increase in chemiluminescence respond suggested a mechanism of cellular damage by increasing reactive oxygen species which can injure surrounding tissues. On the other hand, suppression of respiratory burst can lead to impaired anti tumor of phatogen or tumor cells.

If you have any questions, please communicate with me by phone at (702) 228-4032, or by writing to me at the above address.

Very truly,

Dr. Jacob D. Paz
Encl/

occupational Exposure Exhibit

degreaser was originally designed for use with aqueous cleaners. A commercial cleaner (90% terpene, 10% anionic surfactant) was used in the unit on a trial basis. The degreaser consisted of an enclosed terpene spray wash side followed by an enclosed hot water spray rinse side with an air knife and drying oven at the exit end of the conveyor. The degrearer was equipped with local exhaust vemilation (LEV) on both enclosed spray sides and included a canopy hood over the open conveyor section between the two sides. Sulfur hexaflouride (SF6) tracer gas studies were done to determine the effective air flow through the room. The effective airflow through the room was 10.946 cubic feet per minute or 5.7 air changes per hour. Air samples were collected at eight locations around the room including LEV ductwork. A short term sample was collected prior to the start of degreasing operations. This background d-limonene concentration was 0.03 mg/m3. The average room concentration during degreaser operation was 0.53 mg/m3. The LEV-captured d-limonene emissions were calculated using duct concentrations and duct flowrate. The average captured emission rate was 11,263 mg/min. These emissions were found to be strongly correlated with board throughout and can be described as mg emitted = 2,181 x number of boards degreased + 10,204 (r^2 = 0.96). Board throughput varied from 0 to 57 boards per hour with an average of 29 boards per hour.

Papers 259-264
Electromagnetic Fields: What Should We Be Telling Our Workers?

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THE DETERMINATION AND EVALUATION OF ELECTRO-MAGNETIC FIELDS Alfred F. Steinegger, Health and Safety Consultant, CH 3973- Venthône, Switzerland.

The question of health effects due to the exposure to electromagnetic fields is becoming increasingly the subject of discussion in recent times. There are still many questions open concerning the biological and harmful effects of magnetic fields. Nevertheless it is important to dispose of exposure measurements for instance as a basis for future studies. A possible procedure in different steps for the determination of magnetic fields at the workplace is shown by an example of the primary aluminium industry. High direct currents of for instance 140 000 A are used in producing aluminium by the electrolytic process. As a first step, a rough estimation results a magnetic induction of max.300 G (30 mT) in a distance of 1 meter to the main current conductor. By a sophisticated calculation values of 25 - 100 G (2. 5 - 10 mT) at different locations of the typical working area were derived. In a further step these calculations have been confirmed by stationary measurements at the same places about 1 m above the ground level. At some "hot spots" where the operator stays only occasionally, the values were between 100 - 200 G (10 - 20 mT). We can estimate that the exposure for routine work is less than 100 G (10 mT) which is well below the TLV (ACGIH) of 600 G (60 mT). Personal dosimeters would permit a better evaluation of the exposure at these workplaces. Personal monitoring was ma& with a prototype probe amlyzer. built according to the indications by the Aluminiumindustriens Miljøskretariat/University of Oslo. In combination with a data logger it was possible to get data for a better evaluation of the exposure by dosimetry. Preliminary short measurements for a few hours have given values in the range of 30 - 80 G (3 - 8 mT). These values have 10 be confirmed by a more extended measuring campaign, including values of the dosimetry for single workers over an eight hours shift.

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CHARACTERIZATION OF OCCUPATIONAL EXPOSURE TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS IN A HOSPITAL. K Philips. M. Morandi. University of Texas School of Public Health, P.O. Box 20186. Houston. TX 77225; D. Oehme. P. Clouthier, Innovatum, Inc., 2020 SW Freeway, Suite 203, Houston, TX 77098.

Research on electromagnetic field (EMF) parameters which may be associated with observed bioeffects has produced a complex pattern of relevant exposure parameters, including threshold, window, peak or cumulative values for field intensity and frequency. as well as waveform and geomagnetic orientation. A characterization study of exposures to extremely low frequency magnetic fields (ELF; 40-1000 Hz) as determined by these parameters was undertaken in technical areas of a large research hospital.

Exposure data were obtained through a combination of work/time analysis, specific site surveys, personal EMF dosimeters, and a magnetometer. A wide variation in exposures was observed. For example, computerized to cians' exposures were found to vary in both intensity and spect tribution depending on the workers' location relative to a spec In one station the worker experienced ELFs as high as 38 mG 6.1 excursions/hour over 10mG. and 20% of his EMF exposure 180 Hz, 8% at 360 Hz, and 4.9% at 895 Hz In another static equipment. but different technician traffic pattern, the maximum 9mG (1.76mG-hr), with no excursions over 10 mG, and a exp distribution of 59% at 60 Hz. 9% at 180 Hz and 5.1% at 895 Hz.

The results indicate that significant ELF exposures can occur intensity and spectral characteristics of the exposure vary both tween job categories. and depend on the specific sources and These exposures could be significantly reduced by changing lo tied sources and/or worker's traffic pattern. This approach to characterization is applicable to other occupational settings.

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ELECTROMAGNETIC SURVEY OF EMPLOYEES EXPOS DESTRUCTIVE TESTING (NDT) OF DRILLING PIPE WALKER. J&L Inc., P.O. Box 33036, Las Vegas, NV 89133 Baker, Hughes Tubular Services, Inc. 9400 Bamboo Rd., Houston 7631 and J. Mackin, IPIA International Pipe Inspector Association Rd., Houston, TX 77013, and E. Moss. NIOSH, 4676 Columbia cinnati. OH 45226.

An Electromagnetic (EM) survey of employees testing the integr fitting was performed. Because of concern about the potential he employee exposures to high EM fields. It is estimated that over IL employees are exposed to various high EM levels. Literature rev that the EM field strength generated during NGT is varied and ran to 300 Gauss (G), depending upon pipe size and customer specific erature surveys indicate that EM is *not* a hazardous concern. and considered as a potential health hazard by the American Society of tive Testing in their 1989 handbook.

EM measurements were taken with an ELF Walker Industry Mc MG-D4. The magnetic field was generated by a mobile unit, op Volts and 60 Hz.

The following static EM field strengthes were monitored at magnet taken 1 meter from magnet; ranges from 27 to 119 G were measure urements in the position of the operator's body taken during NDT dures tkaen about 30 cm from coil were: Head 3.0 G; Chest 6.2 G; G; Arm 4.0 G; Shoulder 1.4 G; and, 7.2 G at 1 meter from the source survey it was also noted that the magnetic coil was left in the on p ployees were often observed to neglect closing the switch, consequen ing to expose themselves to continuous high EM field strengthes likely exceeded the new ANSI standard and ACGIH guidelines.

These high values of EM measurements raise serious questions abc health effects to employees exposed to high levels of the EM fields We are recommending that comprehensive EM dosimetric surveys, employees and steps be taken to reduce worker exposures to high EM

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COMPARISON OF EXTREMELY LOW FREQUENCY MAGNET DENSITY EXPOSURES OF ELECTRICAL AND NON-ELE WORKERS AT THE LOS ALAMOS NATIONAL LABORATORY lander, The Los Alamos National Laboratory, P.O. Box 1663, MS Alamos, New Mexico 87545: P.N. Breysse, The Johns Hopkins School of Hygiene and Public Health 615 North Wolfe Street, Baltimore land 21205.

In epidemiologic studies of occupational cohorts exposed to extremely quency (ELF) electric and magnetic fields, the absence of field me data forced investigators to use surrogates of exposure. such as job though the presumption of exposure associated with job titles may be defensible *it* is not possible to determine what ELF field parameters a ated with the excess risk suggested by some of these studies. The purpo study was to evaluate worker exposure to ELF magnetic fields in joi could be readily classified as electrical or as working around large an electricity and to compare these exposures to a sample of non-electrical

Job classification as electrical or non-electrical was based on the Los National Laboratory Health Hazard Assessment (HHA) Operation Codes ferent elecrical workers and 20 comparison workers were included in th Full and partial-shift exposures to power frequency (60 Hertz and bar magnetic fields were measured. Each worker was measured on at let

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ELECTROMAGNETIC PROFILE IN COMMERCIAL AND CORPORATE AIRCRAFT. R.M. Fenster[1], J.D. Paz[2] and J.M. Lamb[3]. [1]Nevada Institute of Environment, Health & Safety, Las Vegas, Nevada 89119, USA. [2]J & L Environmental Services Inc., Las Vegas, Nevada 89128, USA. [3]Global Consulting Services, Las Vegas, Nevada 89108, USA.

OBJECTIVE: Over 500 million passengers utilize an airplane as transportation each year. These occupants are serviced by over 150,000 aircrew each logging an average of 250,000 flight miles every year. Few scientific studies have evaluated EMF as it relates to possible exposure to aircrew and passengers. The primary focus of previous studies was to determine the effects of both intentional and non-intentional non-ionizing frequency radiation on aircraft systems. The objective of this preliminary screening was to determine potential human exposure levels and to identify actual radiator sources.

METHOD: Electric and Magnetic field measurements were made on 101 commercial (Boeing, McDonnell Douglas, Lockheed, and Airbus) and 5 corporate (Gulf, Lear, and Citation) aircraft. Measurements were taken on the ground (no load) and during normal flight conditions (fasten seat belt sign off). Inspections of commercial aircraft during manufacturing (Boeing, McDonnell Douglas, and Allied Signal), maintenance (FAA Tech Center, TWA, Delta, Northwest, United, Alaska Air, American Airlines, and Continental), and handling (AMR Combs) were performed to assist in characterization of field sources. Each aircraft screened was identified by equipment type (ie: 727-200), avionics installed, maintenance and flight logs, and passenger and crew loading. Measurements while on the ground and during normal cruise were taken at pre-defined locations based on aircraft configuration (seat and equipment placement). Additional measurements were taken at pre-defined locations (greatest path loss potential) during taxing (pre and post flight), climbing (0-10,000 feet msl), initial descent, and final approach. Equipment utilized included simple field meters (ie: teslatronics ELF Model 70 and Combinova FD1 & FD2) and more advanced equipment (ie: Combinova MFM100 & EFM 100 and HP oscilloscope & spectrum analyzers). All measurements were taken at distances consistent with proper human factors. The flight deck was screened during ground loading and unloading of passengers plus, occasionally by the pilots during flight at the times defined above.

TEST RESULTS: Spatial and temporal dependence of magnetic and electric fields from electrical and electronic on board equipment are found to vary over a large range. Fields (frequency and amplitude) generating sources (ie: hydraulic and water lines, power supplies, junction boxes, food preparation equipment, interactive video electronic devices, communication systems, etc...) vary based on aircraft type, maintenance, cycles (number of takeoff and landings), and flight phase. Pilot instrumentation located behind the head ranges from 150nT to 470nT (ELF) and 18nT to 95nT (VLF), while significantly higher intermittent spiking of magnetic fields may be exhibited during switching on and off of ventilation and intercom systems. The general cabin average ELF levels ranged from 200nt to 1.3μT at the floor and from 350nt to 1.4μT at the ceiling. Other areas of elevated fields include galley, jump seat, restroom, flight attendant seats, and antenna mounting points.

DISCUSSION: Experimental sampling of aircraft electric and magnetic fields demonstrates a likelihood that aircraft crew members receive significant exposure not only from microwave and radio frequencies, but also power frequencies (50/60Hz and 400 Hz). It also demonstrates a lack of adequate shielding to passengers and crew. The additional exposure from ground power generators, aircraft radar domes, etc. have not been adequately characterized. This work provides a preliminary profile for needed further investigation.

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CHARACTERIZATION OF MAGNETIC FIELD GENERATED FROM ELECTRIC VEHICLES. Sh. H. Berisha[1], G.G. Karady[2], R. Hobbs[3], D. Karner[4] and J. Clark[4]. [1]GateWay Community College, Phoenix, Arizona 85034, USA. [2]Department of Electrical Engineering, Arizona State University, Tempe, Arizona 85287, USA. [3]Arizona Public Service Co., Phoenix, Arizona 85001, USA. [4]Electric Transportation Applications, Phoenix, Arizona 85003, USA.

OBJECTIVE: Magnetic fields generated by different sources are the subject of public concern because of the reported health problems related to exposure to the fields. One emerging source of magnetic fields is electric vehicles. The purpose of this study is to compare the magnetic fields generated by different electric vehicles and to determine the overall expected ac magnetic field in the passenger compartment in future EVs.

METHOD: Three single axis magnetic field sensors are used to measure the fields. A custom designed data acquisition program is used to acquire analog signals from each axis sensor. The dc and rms ac field, was designed to use existing data on the uL~UI"UU"L~ a,"* ten~hmrds of our water distribution system. During the next phase a team comprised of at operations employee and an Occupational Safety and Health Representative evaluated the confined space and collected the necessary data The data management system was populated using existing data bases and supplemented by the data collected from the initial field inspection. Finally. the data management system was tested end released to the users.

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A PEN-BASED COMPUtER APPROACH TO INDUSTRIAL HYGIENE DATA COLLECTION AND ENTRY. R.V.and D.A. Morgan. U.S. Army Center for Health Promotion and Preventive Medicine. Attn: MCHB-Ml-1. Aberdeen Proving Ground. MD 21010-5422.

Health Hazard Information Module Version 2.2 (HHIM) field surveys consolidate valuable industrial hygiene (IH) worksite data. Currently. the HHIM user (e.g.. IH professional) collects the workplace information on a clipboard and paper survey forms. He returns to his office, refers to the HHIM User's guide, codes the data, then manually enters the data into a desktop personal computer (PC) software package, In contrast to this labor intensive method, the use of a pen-based computer (PBC) enables the data to be coded into the HHIM software automatically while in the field. The coded data is electronically transferred from the PBC to the desktop PC. HHIM PBC implementation supports the "paperless office" theory and increases IH program efficiency by eliminating steps in the data entry process. The electronic data transfer procedure increases data quality, accuracy, and integrity. HHIM PBC documentation and alpha test plan development involved user instructions, testing objectives. and an extensive questionnaire to determine the feasibility of using PBCs a instruments for IH data collection. Alpha test results provided the necessary statistics to grant final approval for the implementation of PBCs as IH data entry tools.

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AN UPDATE OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S HEALTH AND SAFETY PLANNER SOFTWARE. I.M. Golden Jr. Halliburton NUS Corporation, 2890 Woodbridge Ave., Edison. NJ 08837; S.M. Burchette, U.S. Environmental Protection Agency, Environmental Response Team, 2890 Woodbridge Ave., Edison, NJ 08837.

In 1989, the U.S. Environmental Protection Agency's Environmental Response Team (EPA-ERT) developed the Health and Safety Planner (HASP). HASP—often called the genetic health and safety plan—is a menu driven software program designed to assist health and safety officers in designing, implementing, and updating a hazardous waste site health and safety plan. HASP originally provided only standard protocols for typical waste remediation and assessment activities, and the format was consistent with OSHA's 29 CFR 1910, 120 and U.S. EPA's 40 CFR 311 requirements.

Revisions of HASP in 1990 allowed users to retrieve data on chemical hazards of the 110 most commonly found chemicals at hazardous waste sites, receive suggestions of appropriate monitoring devices, identify likely routes of exposure, and receive recommended levels of protection based on selected chemicals' hazards and specific tasks to be performed at a site. In 1992, revisions made it possible for users to download information on an additional 2500 chemicals from the EPA-ERT's Bulletin Board System (BBS).

Since 1992, there has been a constant need to increase the number of the chemicals in the database. In addition, the use of HASP in non-typical hazardous waste site activities and emergency response has increased. In 1995, EPA-ERT has responded to these situations by revising HASP again. The latest version of HASP allows users to add both new chemicals and new tasks to the HASP databases. These user defined chemi-HASP in a variety of situations and by variety of users.

Papers 52-57 Nonionizing Radiation

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OCCCPATIONAL AND NON-OCCUPATIONAL EXPOSURES OFTECHNICIANS IN A NUCLEAR MAGNETIC RESONANCE IMAGING CLINIC TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS. F. and D.H. Dragt, Mrdical College of Ohio. Department of Occupational Health. P.O. Box 10008, Toledo. Ohio 43669-0008.

This study was designed io assess the exposure of nuclear magnetic resonance imaging (MRI) workers to exttemely low frequency magnettc fields (ELF-MF). Researchers recruited 6 workers (3 MRI technicians and 3 controls) for the study. Subjects used a personal dosimeter to collect minute-by-minute ELF-MF doses for a 24-hour period including 7-8 hours of their occupational exposures. Subjects were instructed to record on a log sheet their occupational and personal activities throughout the 24-hour period when their exposures were monitored. The workers' environmental exposures were also monitored by using a direct reading magnetic field meter. The data of personal exposure were downloaded to a computerized statistical software package for data analysis.

The occupational exposure of the MRI technicians to ELF-MF ranged from 0. I io 17.8 milligauss (mG) and their non-occupational exposure ranged from 0. I to 10.0 mG. The MRI technicians had a significantly higher time-weighted average (TWA) occupational exposure than both their own TWA non-occupational exposure (1.7±0.3 v I .0±0.2 mG) and the TWA occupational exposure of the control group (I .7±0.3 v 0.9±0.2 mG).

The results showed that certain tasks/activities, such as operating the control panel located outside the examination room or working in the computer room. exposed technicians to relatively high levels of ELF-MF. The scattergrams, which demonstrated each subject's cxpo cure to ELF-MF in relation to time and work activities. were an effective means of making recommendations to modify those tasks or conditions that contributed considerably to each worker's exposure.

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CONTROL OF VIDEO DISPLAY TERMINAL INTERFERENCE CAUSED BY MAGNETIC FIELDS FROM 60 HZ ELECTRIC POWER. H.E. McLoone. Apple Computer. Inc., 20450 Stevens Creek Blvd., MS: 76EHS. Cupertino, CA 95014.

The uncertainty about the chronic adverse health effects from low-level exposure to magnetic fields (i.e.. magnetic flux densities of B-fields) from 60 Hz electric power has created challenges for industrial hygienists. In the general otticc environment. industrial hygienists have a responsibility to explain the health risks to exposed persons and to recommend control measures. The low-level electromagnetic fields are often three to four orders of magnitude below the ACGIH recommended exposure limit. Conversely, to the dismay of the exposed person, the B-fields may be two orders of magnitude higher than background levels. A survey meter cm determine the exact location and magnitude of the B-fields. And. the U.S. workplace has millions of mag netic field detectors. namely video display terminals (VDTs) for computers. A visible wiggle or distortion on VDTs is produced by magnetic fields as low as 7 milli-Gauss. The wiggle may contribute to visual discomfort such as eye fatigue. eye strain. or headaches. The source of interfering B-fields is the electric current flowing from the electric power distribution in floors. ceilings or adjacent rooms: from power distribution and transmission lines outside the building; or from electric appliances such as tack lighting or other BDTs. Engi-electric power lines are often expensive or infeasible. Yet, many control measures are simple and effective: r position VDT away from source; relocate monitor to ai other area in the same office; or rearrange office floor plan. The B-fields cm also be the result of a damaged or improperly installed neutral conductor, allowing the neutral current to return through multiple ground paths The location of the neutral fault can usually be found and repaired. Then. the current flows in equal and oppc site directions. canceling their respective B-fields. By controlling the magnetic field interference of BDTs, in dustrial hygienists prevent adverse health effects from visual discomfon and, at the same time, diminish the persons' fear from uncertainty about the B-field exposure level and the indefinite adverse health effects.

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SURVEY OF ELECTROMAGNETIC RADIATIOI EXPOSURE TO LABORATORY WORKERS OPERATING ANALYTICAL INSTRUMENTATION. J.D. Paz, J&L Environmental Services, 7700 Wolf Creek Road. Las Vegas, NV 89128; S.K. Van Wagenen, Nevada Environmental Laboratory. 4208 Arcata Way, La Vegas, NV 89030.

The purpose of this survey was to evaluate the level of electromagnetic (ELF) radiation laboratory workers are exposed to while operating analytical instruments. Each year, an estimated one million laboratory workers are exposed to varying levels of ELF radiation from various types of analytical instrumentation. The inductively coupled plasma-mass spectrometer (ICP-MS) an gas chromatograph (GC)-MS are of particular interest because of the high voltage and magnetic field generated by each during operation. ELF radiation exposure testing for this survey was performed in two stages using a Walker Scientific ELF Field Monitor ELF-60D. first. exposure was measured at a distance of about 30 centimeters from each instrument while idle. Second. exposure was measured at the same distance from the same instruments during operation. Test results indicated that exposure levels of ELF radiation while instru ments are in operation are significantly higher than when they are idle. Exposure levels during operation were as follows: ICP (I .3 to 20 mG); pH/MV (4.2 to 5.2 mG). spectrophotometer (I.2 to 11.2 mG); microscale (3.5 to 5. I mG); graphite furnace atomic absorption (FGAA) (14 to 113 mG; AA (3.0 to 13mG); ion chromatograph (2.6 to 5.0); magnetic stirrer (0.0 to 125mG) depending on power output: furnace (15 mG); pump (15. I to SO mG); GC_MS with an RF-power source (6. I); GC-MS (100 to 500 mG); GC (6.1); GC autosampler (3. I to 24. I mG); drying oven at 120°C (30 to 60 mG); heating until (30.I. to 160 mG). ELF radiation exposure levels did not exceed American Conference of Governmental Industrial Hygienists threshold limit value (TLV). In most cases, however, laboratory instruments in operation exceeded the 2.5 mG level of ELF radiation recommended in Sweden. and may be hazardous to laboratory worker's health Of particular concern is the high voltage used to power an ICP-MS and GC-MS and the high magnetic field generated by high resolution MS. We believe that a potential health hazard exists in analytical laboratories, specifically to laboratory workers exposed to ELF radiation. We recommend further evaluation of ELF radiation exposure and an epidemiological study of laboratory work ers who are exposed to high voltage and ELF radiation.

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ELF EXPOSURE ASSESSMENT OF HEALTH CARE WORKERS. G. Enescu and C.H Rice. University of Cincinnati. 3223 Eden Avenue. Cincinnati. OH 45267; C.E. Moss. National Institute for Occupational Safety and Health. 4676 Columbia Parkway. Cincinnati, OH 45226.

An exposure assessment was recently conducted at a medium size hospital to determine the nature and magnitude of electric and magnetic fields (EMF) exposing health care workers (HCWs). This study was performed

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ELECTROMAGNETIC PROFILE IN COMMERCIAL AND CORPORATE AIRCRAFT. R.M. Fenstert[1], J.D. Paz[2] and J.M. Lamb[3]. [1]Nevada Institute of Environment, Health & Safety, Las Vegas, Nevada 89119, USA. [2]J & L Environmental Services Inc., Las Vegas, Nevada 89128, USA. [3]Global Consulting Services, Las Vegas, Nevada 89108, USA.

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P-36

CHARACTERIZATION OF MAGNETIC FIELD GENERATED FROM ELECTRIC VEHICLES. Sh. H. Berisha[1], G.G. Karady[2], R. Hobbs[3], D. Kamer[4] and J. Clark[4]. [1]GateWay Community College, Phoenix, Arizona 85034, USA. [2]Department of Electrical Engineering, Arizona State University, Tempe, Arizona 85287, USA. [3]Arizona Public Service Co.. Phoenix, Arizona 85001, USA. 4Electric Transportation Applications, Phoenix, Arizona 85003, USA.

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Recreational Exhibit 2

as a consequence the magnetic field in the vicinity of the lines has two (or in general three) orthogonal components which differ in intensity and phase. Resulting vector rotates in space with frequency f=50 Hz and the field is ellipticaly polarized. How large area will be affected by the rotating field depends on many factors, primarily on the intensity of the currents and wire configuration. For example, a transmission line with nominal current 200 A, consisting of three symmetrical bunches of wires in the same plane, 6 m far from each other and 10 m above the ground, produce rotational field in buildings under wires.
Standard magnetic field meters with three axes probes are not able to detect whether the field is rotational or not, because in the case of the rotational field standard meter detects only the intensity which corresponds to the major axis of the ellipse. For this reason we designed a microprocessor based meter of our own which is able to detect the presence of the rotational field.
What may be the biological effect of such field? Presence of the two orthogonal components seem not only to increase the resulting field intensity but also to increase the possibility for AC/DC resonant conditions, and by that effectiveness of such field.,
In order to start the investigation in this direction we explored a few locations in the neighborhood (110 kV, 200 A line, always B less than 10 µT) in the zone of the rotational field. Four family houses and one small ambulance building were considered. Our findings were alarming. We found cancer patients in each place: House # 1 - ovarian tumor, 24 years old female, house #2 - breast cancer, 70 years old female (died), house #3 - leukemia, 9 years old female, house #4 uterovesical cancer, 43 years old female, ambulance - leukemia, 37 years old doctor, female (died), ambulance - ovarian cancer, 32 years old dentist, female.

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ELECTROMAGNETIC EXPOSURE SURVEY CASINO GAMBLING VIDEO MACHINES. J.D. Paz*[1] and J.L. Foley*[2]. [1]J&L Environmental Services, Las Vegas, NV 89128 USA. [2]Henderson, NV 89015 USA.

The purpose of this survey was to evaluate casino patrons and workers who are exposed to potential levels of electromagnetic-field radiation (ELF). Prior to this study, a review of the professional literature concerning (ELF) exposure from video gambling machines was non-existent. The Finnish Institute of Occupational Health reported on a multi-year study that linked (ELF) generated by Video Display Terminals (VDT) with increased miscarriages among clerical workers. Specifically, pregnant women exposed to 3 milligauss (mG). Recently, two Swedish studies show a link between (ELF) and increased Leukemia risk among children and adult males, of a similar strength exposure to (ELF). Electromagnetic exposure measurements were performed in two stages. Measurements were performed when the machine is idle and secondly a set of measurements were recorded during the gambling cycle. Electromagnetic radiation measurements were recorded on a player, particularly to the following exposed areas of the head, hands, and chest, including the lower extremities while a casino patron was sitting at a video poker machine at a distance of 30 centimeters from the screen. Measurements were recorded using a Walker Scientific ELF filed Monitor ELF-60D. Preliminary exposure levels indicated that during the machine cycle, were somewhat gather then the idle cycle. Player body exposure during machine standby condition were as follows: Head 24 mG, Hands 20 mG Chest 4.7 mG and Lower Extremities 1.0 mG. Exposure levels during the active cycle of machine playing follows: Head 27.7 mG, Hands 19.0 mG. Chest 5.0 mG. and the Lower Extremities 1.1 mG. The electromagnetic radiation levels did not exceed current American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values (TLV) for non-ionizing radiation for occupational exposure. Gamblers spend an inordinate amount of time at these video poker and similar machines. Their exposure levels exceeded the 2.5 milligauss recommended by the Swedes, and may lead to the advent of health problems. The authors recommended that further evaluation including LEF measurements, and development by the manufacturers of low energy emitting radiation VDT less then 2.5 mG devices similar manner sold by some computer brand.

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ELF ELECTROMAGNETIC FIELDS AND FRENCH HIGH SPEED TRAIN. R. Santini[1], P. LeRuz[2], J-M. Danze[3] and J-L. Mercier[2]. [1]National Institute of Applied Sciences (INSA) Bat 406, 69621 Villeurbanne Cedex, France. [2]ABPE, 35700 Rennes. France [3]Harze Belgique.

Most of the lines of the French railroad are electrified with 25 KV- 50 Hertz traction current, but for high speed train requirements arc higher (600 Amperes) than those of a conventional one (200 Amperes)(1). In view of radioprotection of passengers and railway workers against ELF electromagnetic fields, we have measured 50 Hz electric (E) and magnetic (B) fields inside (at passenger seat) and outside (along the line) of high speed trains. The measures have been done using a EFM meter - Model 130 (electric field measurement P.O. Box 326, Stockbridge MA 01266) and a HI - 3604 ELF Power frequency Survey meter (Holaday industries). In the train, during a 2 hours travel (LYON-PARIS and RENNES-PARIS). we have observed that: - in the station, electric and magnetic fields were low (1 up to 2 V/m for the E field, 0.5 up to 0.7 mG for the B field), when the train was not at high speed, the E field values remained low (1 V/m) and the B field values slightly increased (0.9 up to 1.6 mG) - when the train was at high speed, the E field was not modified (1 V/m), but the B field was strongly increased (up 10 63 mG). It appears that the magnetic field values were not stable and rapidly (but irregularly) oscillated between low (1 up to 2 mG) to high levels. We have also measured highest values of the B field during passages in front of electrical stations along the line (>70 mG). Outside of the train we have measured during the passage of the train in front of us (the train being at high speed): - for magnetic field, 60 mG at 10 meters of the line, 25 mG at 30 meters and 5 mG at 50 meters - for the electric field, values were inferior to 10 V/m. From our results it appears that inside of the train, the B field is strong during the time of high speed. and that it oscillates between low and high values, creating magnetic flash which might be dangerous for exposed people. Outside of the train, the B fields is strong near the lines, and falls to non dangerous values (<2 mG) at a distance of 100 meters. In conclusion we think that magnetic fields emitted by high speed train might be dangerous for exposed people because measured fields are in the range where biological effects are reported.(2)

1) Gourdon, C.G. (1993) Efforts of French railroads to reduce traction electromagnetic fields. Electricity and magnetism in biology and medicine. San Francisco Press Inc. p 259-263.
2) Santini R. (1993) Biological effects of extremely low frequency electromagnetic fields. International Symposium. European Parliarnent in Press.

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RESULTS: Typical sample data are: Average and Maximum Current Densities Induced by Hair Dryers and Electric Shavers

Appliance	Magnetic Moment ($m^3 \mu T$)	Distance appliance-surface to head-surface (cm)	Current Density (nA/cm^2) in 5 mm layer	
			average	maximum
Hair Dryers	0.00315	2.3	1.7	11
	0.00315	5.3	0.9	4.7
	0.23	2.3	136	800
	0.23	5.3	67	340
Electric Shavers	0.05	2.5	27	175
	0.31	2.5	164	1080

DISCUSSION: The induced current density rapidly decreases with the distance from the appliance. The maximum however, predictably is not at the surface, because of the geometry of the head. For typical appliances, the values of the maximum current densities are high as compared to those induced by a uniform magnetic field. According to the computations reported elsewhere for a horizontal field of 0.1 and 0.3 µT, the maximum current density in the head is 0.2 to 0.6 nA/cm^2. The induced currents also strongly depend on the distance between the appliance and the head. Similarly, average current densities in one 5 mm thick layer of tissue, where they are the highest, are considerably greater for the appliances considered here than for a uniform magnetic field. However, the whole-body averaged current densities are much smaller than for uniform exposure fields. For occupational exposures in some rare cases, fields up to 100 µT are encountered resulting in current densities comparable to those from some appliances, but spread over larger tissue volumes. Typically, the appliance-induced 60 Hz currents, while greater than those due to ambient uniform fields, are relatively weak.

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P-58

ELECTROMAGNETIC SURVEY OF CHILDREN VIDEO ARCADE. J.D. Paz[1], J.L. Foley[2] and J.M. Lamb[3]. [1]J&L Environmental Services, Las Vegas, Nevada 89128, USA. [2]Henderson, Nevada 89015, USA. [3]Global Consulting & Research, Las Vegas, Nevada 89108, USA.

OBJECTIVE: The purpose of this survey was to evaluate children who are exposed to potential low levels of electromagnetic-field radiation (ELF) from video games. Prior to this study, a review of the professional literature concerning ELF exposure from video arcade, was non-existent. Recently, two Swedish studies show a link between ELF and increased leukemia risk among children and adult males, when exposed to 3 mG ELF.

METHODS: ELF exposure measurements were performed on several arcade games: for example, pin ball and various video games. ELF monitoring was conducted with the video gaming idle and secondly a set of measurements was carried out during the playing cycle. Electromagnetic radiation monitoring was recorded on a child, particularly to the following exposed areas of the head, hands, and chest, including the lower extremities while a the child was at a distance of 30 centimeters from the screen. Measurements were recorded using a Walker Scientific ELF filed Monitor ELF-60D.

RESULTS: Preliminary test results indicated that exposure levels during the game cycle were greater than the idle cycle. ELF exposure during video standby condition were as follows: head/eye positions were ranging from 2.6 to 9.9 mG; chest ELF levels measurements were ranging from 1.0 to 4.0 mG, hands were ranging 1.0 to 3.0 mG. Exposure levels during the active cycle of playing follows: head ELF levels were measurements made were ranging from 2.0 to 11.9 mG; ELF at child chest ranging from 2.0 to 6.9 mG, Hands were 2.0 to 16.1 mG. ELF flux density taken at the VDT screen were raining from 16.0 to 51.3 mG in gaining cycle.

DISCUSSION: Children who play an inordinate amount of time at these video arcade and/or similar machines, have exposure levels exceeding the 2.5 mG recommended by the Swedes, which may lead to

Ex. 6.1.3

POSTERS

Cells

P-l

SPONTANEOUS OSCILLATION RATES IN HUMAN LEUKEMIC JURKAT CELLS OBTAINE FROM THE ATCC. R.B. Stagg, L.J. Kinne, R.A. Jones and W.R. Adey. J.L. Pettis Memorial Veteran Administration Medical Center, Loma Linda, California 92357, USA.

Spontaneous calcium oscillation rates in, cultured Jurkat cells have been used as a possible explanation (for the electromagnetic field (EMF) effects reported by Lindstrom *et al.* (2). A 40% rate of spontaneous oscillations has been reported for Jurkat cells (3), although the pattern of oscillations varied for individual cells.

OBJECTIVE: The studies reported here were designed to determine the number of spontaneous oscillating Jurkat cells during normal tissue culture handling conditions.

METHODS: For these studies we have used single cell digital image analysis of fura-2 fluorescence characterize the spontaneous calcium oscillation rates in Jurkat cells. ETM Systems (Irvine, CA) image processor and software connected to a Zeiss microscope based imaging system was used to collect, ration and analyze fura-2 images. Jurkat cells (ATCC, Rockville, MD) were grown in RPMI 1640 medium with 10% FBS at 37 °C and 5% CO_2. Uncentrifuged suspension cells were loaded with fura-2 (5 µM) are allowed to settle on 25 mm round glass cover slips coated with poly-L-lysine. Images were collected every six seconds for 15 min. at 37°C and 5% CO_2.

RESULTS: In 12 individual experiments we have examined 2186 Jurkat cells (average of 182 per experiment). The average spontaneous oscillation rate observed for these cells was 41.8% with a range from 11-76%. Culture conditions that might be associated with logarithmic growth states (days in culture) did not correlate with spontaneous oscillation rate. However, Jurkat cells that maintained a stable baseline $[Ca]_i$ for the first 5 min. demonstrated only a 13.1% average spontaneous rate (range 2.7-26%) during the next 1 min.

DISCUSSION: Lindstrom *et al.* have reported (2), in their original paper, an increase in intracellular calcium oscillations induced by 50 Hz MF in 17 of 20 cells (85%). Technical considerations allowed only single ceil analysis per exposure in those experiments. Lindstrom applies a highly selective process in determining which cells are to be analyzed, requiring among other criteria a 4 min. stable baseline before exposure to MF. We see spontaneous oscillations in 13.1% of Jurkat cells that maintain a stable baseline For this reason spontaneous oscillation rates alone cannot be used to explain the Lindstrom *et al.* observations.

1. Walleczek J *et al.* (1994) DOE Ann. Review (11/6-11/10) Albuquerque, New Mexico, #A-1.
2. Lindstrom E *et al.* (1993) *J Cell Physiol* 156:395-398.
3. Payet MD *et al.* (1991) *Cell Calcium* 12:325-334.

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P - 2

CHANGES IN MACROPHAGE CHEMILUMINESCENCE FOLLOWING EXPOSURES TO LOW INTENSITY 60 Hz ELECTROMAGNETIC FIELDS. M.T. Kleinman[1] and J. Paz[2]. [1]University of California, Irvine, Irvine, California 92717, USA. [2]J & L Environmental Services, Inc., Las Vegas, Nevada 89133, USA.

OBJECTIVE: Studies of health effects associated with 60-Hz electromagnetic fields (EMF) have yielded inconsistent results. Some, but not all, studies have demonstrated associations between EMF exposures an leukemias and cancers in children, and cancers, birth defects or miscarriages in adults. Some of the purported effects of EMF may relate to immune system function, and studies with laboratory animals have indicated that EMF exposures can effect levels of immune system components, under certain conditions The study objective, therefore, was to investigate effects on immunologically active cells, macrophages following *in vitro* exposure to EMF at field intensities which bracketed those measured while operating various equipment in a laboratory, to determine a dose-response relationship.

METHODS: Macrophages were isolated from the respiratory tract of Fischer 344 rats by bronchoalveolar lavage with buffered balanced salt solution. The cells were pooled and aliquots (5 x 10^5) were incubated in polycarbonate cuvettes at 37 °C and non-adherent cells were removed by washing. The medium was replaced with a nutrient-containing medium and the cuvettes were inserted into an EMF field-generating coil and the cells were exposed to field intensities of 0, 50, 100, and 500 milligauss for 1 hr. Field intensities were measured using a Walker ELF 600 Field Monitor. The cuvettes were subsequently transferred to an LKB-Pharmacia L 1250 luminometer. Lucigenin-amplified chemiluminescence, which responds to the presence of reactive oxygen species, was measured before and after stimulation of the cells with opsonized zymosan. Chemiluminescent activity was recorded in mV and the results from 4 replicate studies were statistically analyzed using a repeated measures analysis of variance.
RESULTS: The responses of macrophages to EMF exposure suggest that low doses (50 and 100 milligauss) tend to increase chemiluminescent activity while the higher dose (500 milligauss) depressed superoxide dismutase-inhibitable chemiluminescent activity.
DISCUSSION: These preliminary results suggest that low intensity EMF can alter macrophage superoxide production during respiratory bursts. Macrophage respiratory burst activity is an important immunological defense mechanism in which macrophages, activated by opsonized pathogens, release free radicals and other biocidal compounds to kill potentially infectious agents. Upregulation of this process by exposure to environmental agents can result in excessive releases of reactive oxygen species which can injure surrounding tissues. On the other hand, suppression of respiratory burst activity can lead to impaired killing of pathogens or tumor cells, hence could be related to increased risks of infection or impaired anti-tumor defenses. The biphasic nature of the response curve observed in this study may provide a partial explanation for the lack of some epidemiological studies to provide monotonic dose-response relationships. This study suggests that macrophage chemiluminescence is a useful screening tool to examine the biological and immunological effects of EMF. Future work will focus on the effects of cumulative doses, and the potential of synergistic responses between EMF and other, known, immunoactive environmental contaminants such as heavy metals or solvents.

P-3

A REPLICATION OF ORNITHINE DECARBOXYLASE ENHANCEMENT BY 60 HERTZ MAGNETIC FIELDS. L.W. Cress, A.B. Desta, D.P. Thomas and M.L. Swicord. U.S. Food and Drug Administration, Rockville, Maryland 20857, USA.

OBJECTIVE: Litovitz *et. al.* (1991, *Biochem. Biophys. Res. Comm.*, 178:862) have previously demonstrated that a weak, extremely low frequency magnetic field could enhance the activity of omithine decarboxylase (ODC) in mouse L929 cells. Due to the importance of ODC as a marker for cell proliferation and tumor promotion, this study was one of those chosen for an attempted replication under the National Electric and Magnetic Fields Health Effects Research Program sponsored by the U.S. Department of Energy and the National Institute of Environmental Health Sciences.
METHODS: We have attempted to replicate the original investigators' methods in as exact a manner as possible. Cell culture medium, serum. and assay reagents were obtained from the same vendors and prepared using what we believe to be identical protocols. Cell lines were obtained from both Litovitz *et. al.* and the American Type Culture Collection (ATCC). Initially we exposed cells at the conditions previously reported to give the maximal (two-fold) enhancement: 100 milligauss for four hours. The horizontal 60 Hz magnetic field vector was generated by Helmholtz coils located inside a mumetal shield box in an incubator at 37±0.3 °C. Control cells were sham exposed in an identical mumetal box in the same incubator. Temperatures and magnetic fields were continuously monitored and recorded during all experiments. Following exposure cells were lysed in buffer and assayed for ODC activity by incubation with ^{14}C-Omithine with capture and quantitation of released $^{14}CO_2$.
RESULTS: When L929 cells are exposed in our facility, we do not observe an enhancement of ODC activity. This is true whether the cells are obtained from the original investigators or ATCC. This led to efforts to more closely duplicate the exposure conditions of Litovitz et. al. Measurements at their facility revealed a small residual DC magnetic field which we attempted to simulate using a coil energized with DC current. These efforts did not improve the agreement with the prior results. Interestingly, however, when we transported cells to the original investigators' facility for exposure, and repeated the ODC assay here, we were always able to observe a doubling of ODC activity.
CONCLUSION: We believe that our inability to replicate the ODC enhancement in our exposure facility suggests that some unknown characteristic of the magnetic field, in addition to field strength, is critical for

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